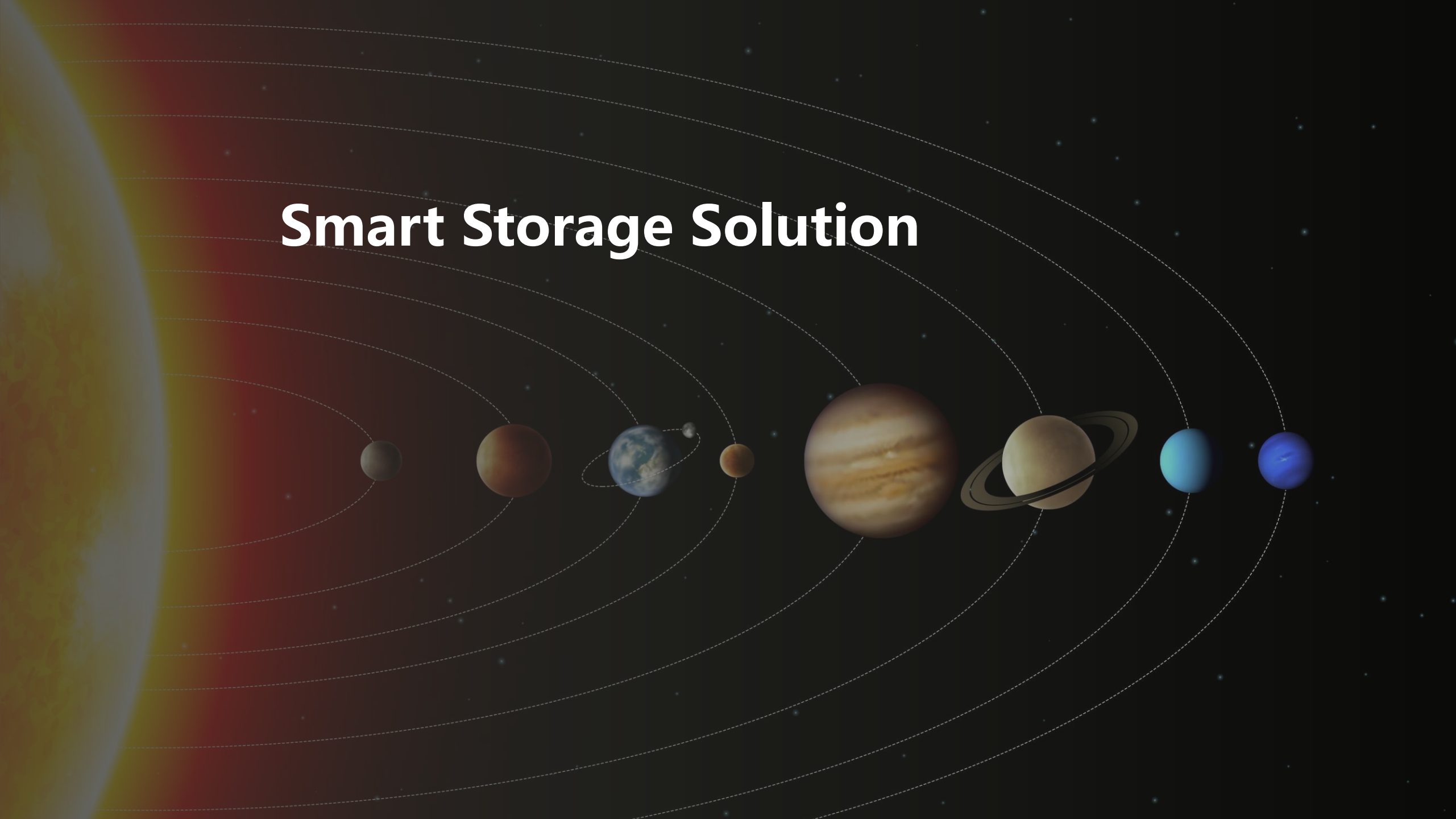


# Smart Storage Solution





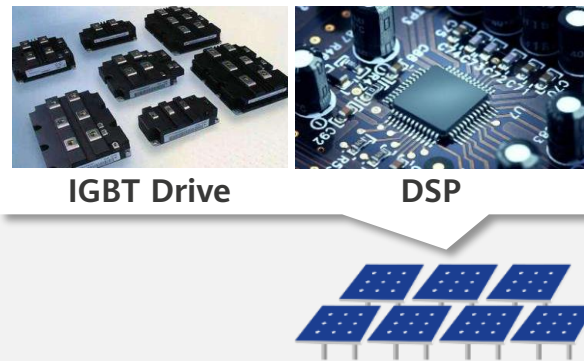
**Trend & Challenge**

**FusionSolar Smart ESS Solution**

# Storage - Necessary Enabling Technologies

Promoting Renewable Energy from Grid Adaptation to be Grid Forming

## PV



### Current Source

Grid following  
Passive acceptance

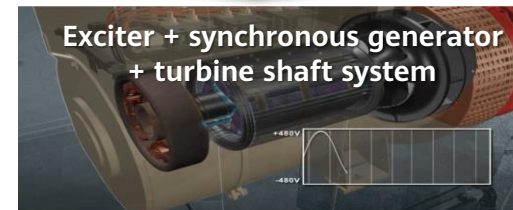
Primary energy:  
**cannot be stored**  
Secondary energy:  
**difficult to control**

## PV + ESS + Algorithm



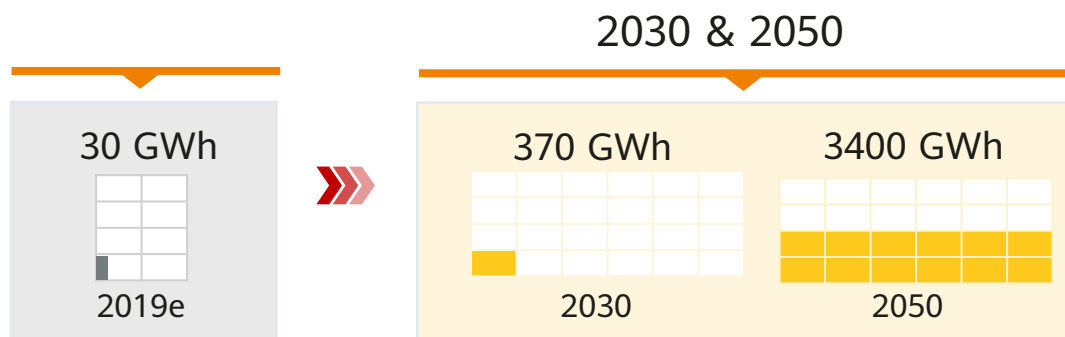
### Voltage Source

Grid Supporting  
Proactive integration



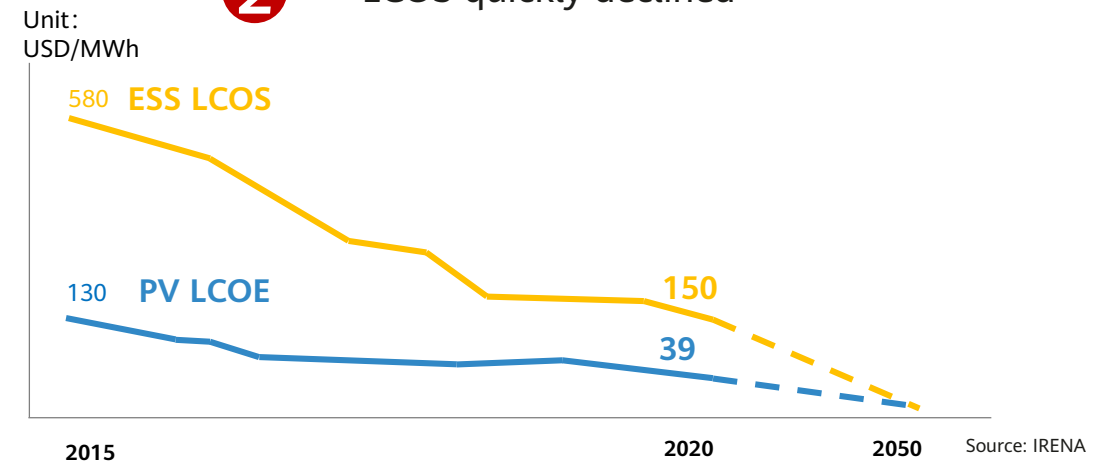
Primary energy:  
**can be stored as electricity**  
Secondary energy:  
**easy to control**

### 1 Grid Storage capacity with rapidly growth



Source: IRENA

### 2 LCOS quickly declined



Source: IRENA

# Major Problems of Current ESS for Lower LCOS

## Existing Fire & Explosion Hazard



ESS Project in Korea  
23 plant burst fire in 2017

### Main cause of fire

- The ternary lithium structure of the battery cell is unstable.
- The battery cell defect is not identified during operation.
- Key components (such as circuit boards and contactors) failure causes sparks and arcs.

## Low System & Battery Utilization Efficiency

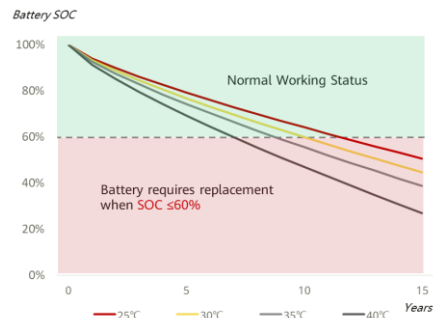


ESS project in China  
System efficiency < 80%

### Main cause of low efficiency

- Mismatch between battery modules & battery racks causes significant battery capacity loss
- Ventilation & air cooling account for 10%+ of charged energy

## Short Battery Life Requires Multi-times Change



Battery lifespan of ESS is 7-10 year

### Main cause of short battery life

- Poor cooling system design causes temperature difference of batteries to 10°C, reducing lifespan by 25%
- Temperature difference between modules & racks further increase module difference, shortening new battery lifespan

## Massive Time-consuming Manual O&M



ESS project in China, experts need to manually inspect all modules in the plant

### Main cause of hard O&M

- Onsite installation of battery modules is required during commissioning.
- Routine O&M requires professional experts
- Experts from suppliers are required in troubleshooting.



**Trend & Challenge**

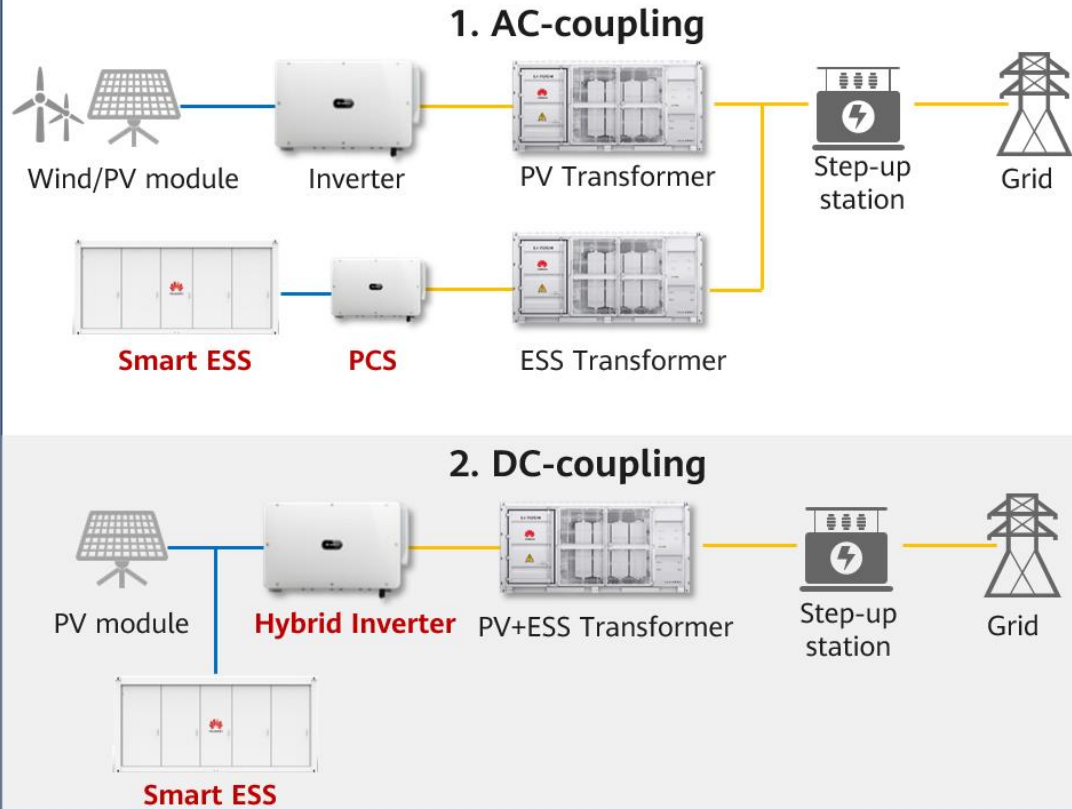
**FusionSolar Smart ESS Solution**

# Gemini Architecture for Solar-storage Synergy

Create Smart PV Generator for the Future

## AC/DC Coupling Solution

## Solution Advantage



Smart PCS	
Rated output power	200kW
Max. Efficiency	99%
Max input voltage	1500V
Rated output voltage	800Vac



Pre-fabricated Smart ESS	
Rated Capacity	2.064MWh
Cell Type	LFP cells
Container size	20 feet
Protection Level	IP55

## Distributed ESS Architecture

### Optimal Configuration

Reduce initial battery by >13% under same EOL

### Extended Life

Temp-rise <5°@1C  
For 15-year battery life

### Simple O&M

Annual OPEX saving  
~\$850/MWh

### Safe & Reliable

Availability up to 99.9%  
AI-aided fire risk prediction



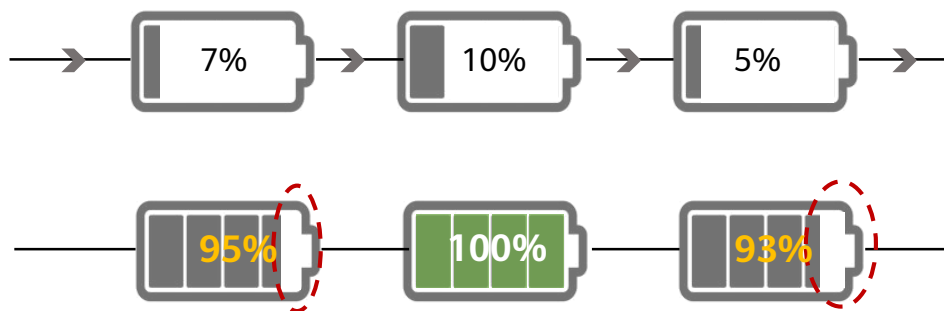


# Pack-level Optimization, Less Capacity Loss inside Racks

Reducing Initial Battery Configuration by ~6%

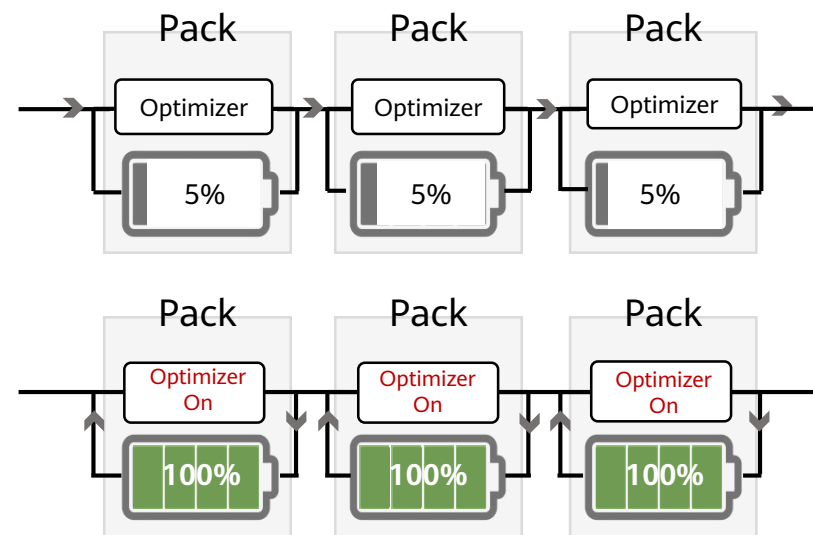
## No-Balancing Design

- SOC difference between packs causes **insufficient battery utilization**
- Battery packs can not **fully charge or discharge** at the same time



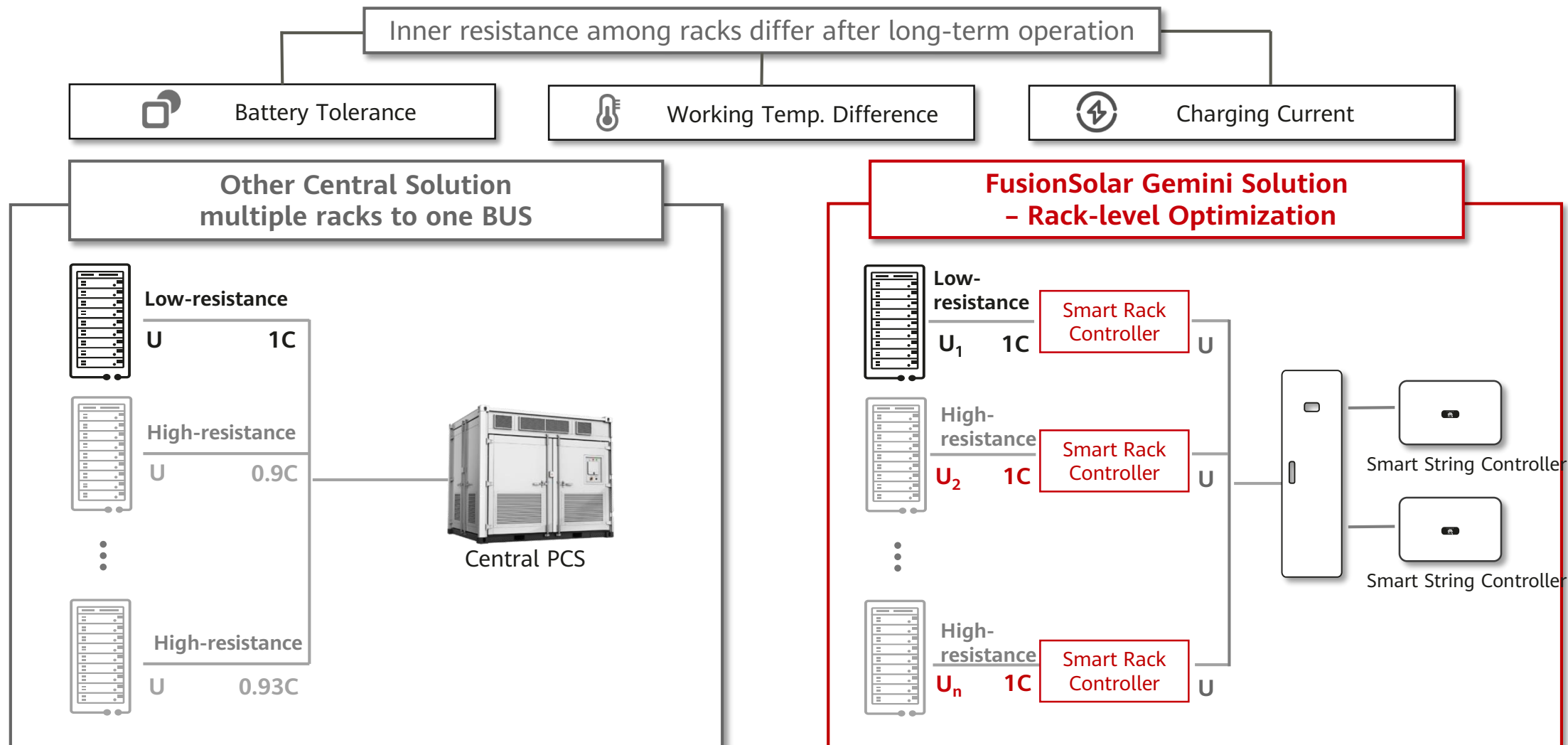
## Optimizer in Every Pack

Ensure each pack to fully charge & discharge



# Rack-level Optimization to Avoid Loss from Rack Mismatch

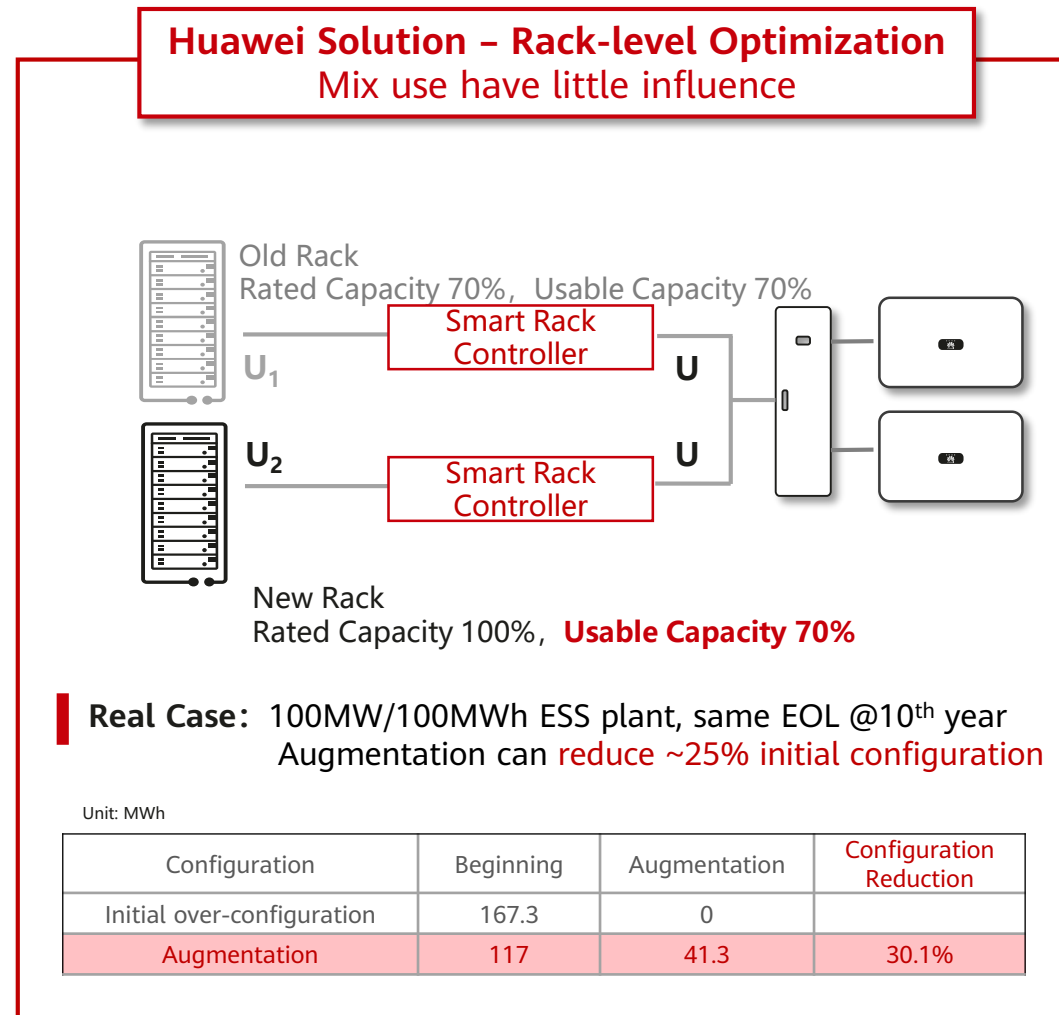
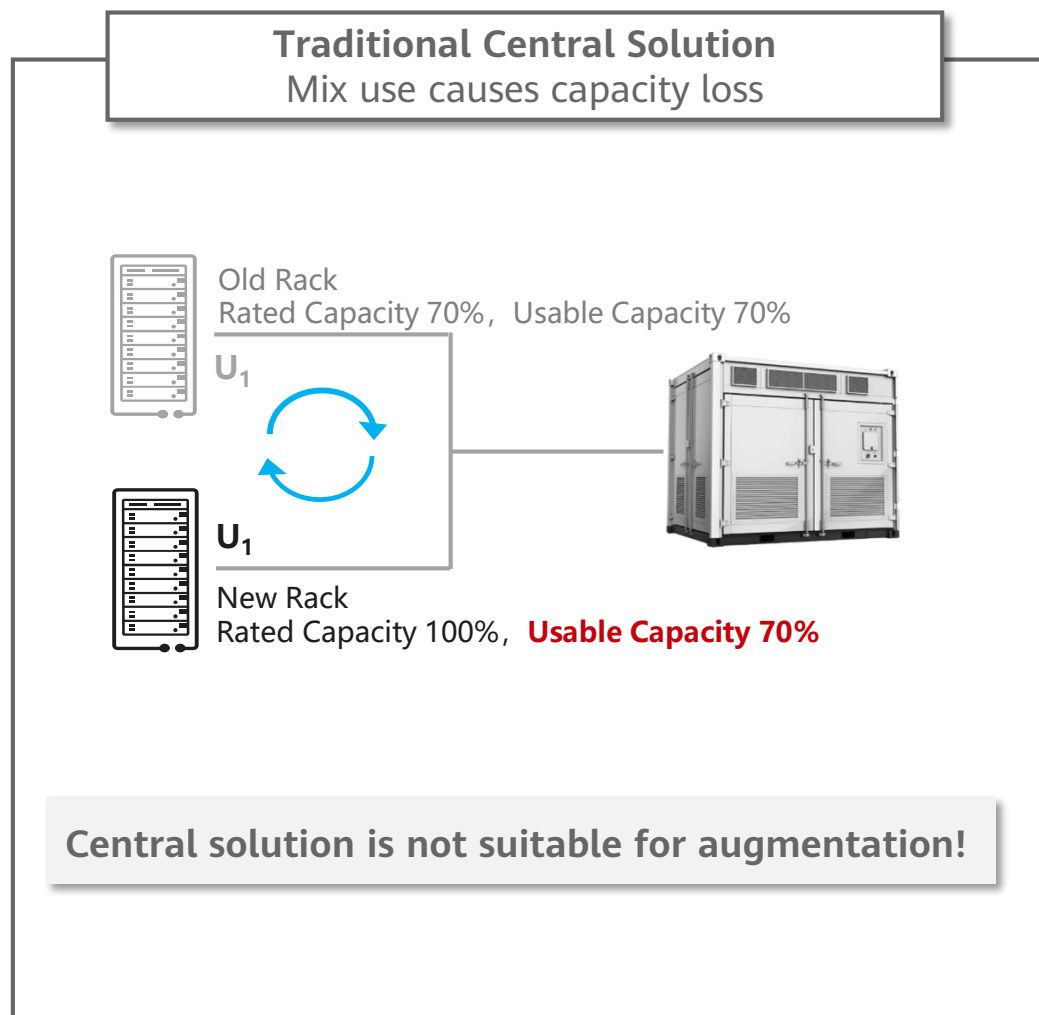
Reducing Initial Battery Configuration by ~7%





# Mix-use of Old & New Batteries, Enabling Battery Augmentation

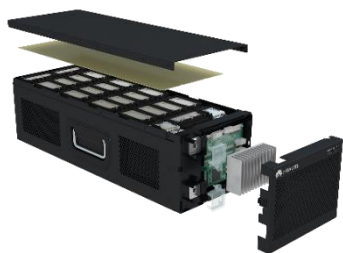
## Reducing Initial Battery Configuration by >25%



# Smart Cooling Design, Temp-rise inside Container $<5^{\circ}\text{C}$ @ $1\text{C}$

## Ensure Battery 15-year Operation

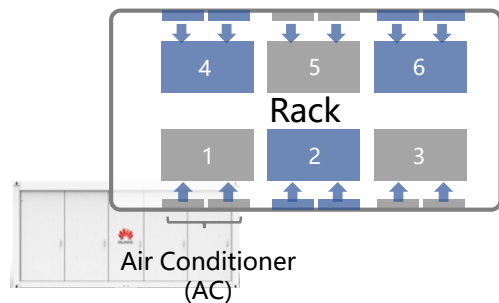
### Pack – Patented Even-Cooling



Temp difference among cells inside the pack  $<5^{\circ}\text{C}$ @ $1\text{C}$

Reduce cell difference for optimal battery utilization

### Container – Distributed Cooling



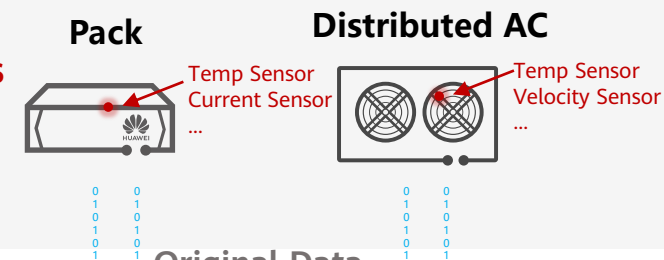
Distributed AC to replace centralized AC

Each rack is cooled individually to minimize temp-rise difference in the container

### Algorithm – Multi-model Smart Cooling

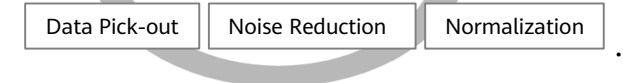
#### 1 Mass Built-in Sensors

Data are fully collected and uploaded



#### 2 Auto Data Filter

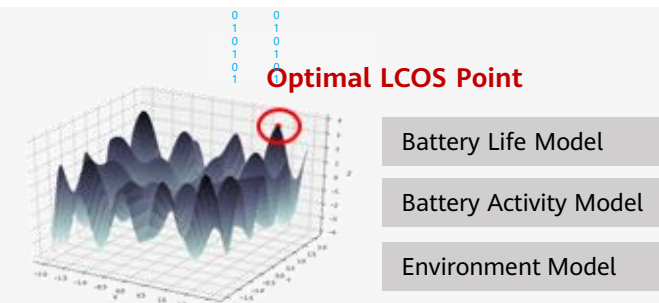
Select temp-control-related parameters



Publicized Data

#### 3 Smart Algorithm Optimization

Change cooling strategy for optimal LCOS, live



# Spare Battery Packs Direct Plug-and-Play

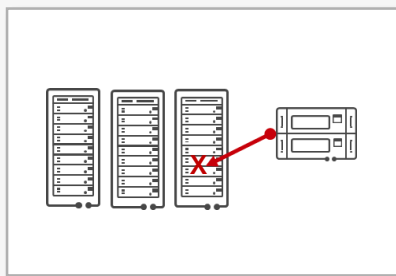
## No need of Expert for On-site Troubleshooting

### Huawei Solution – Experts are not required for on-site troubleshooting

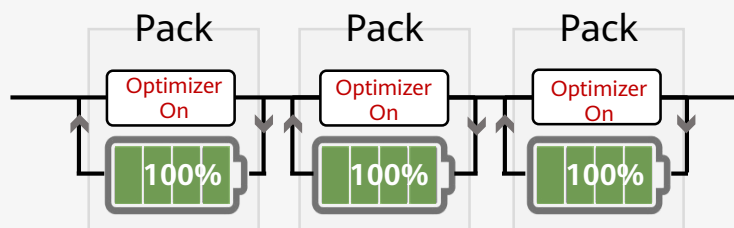
① O&M personnel visit the site



② Replace the pack onsite



Auto-adjustment of new battery packs  
No manual adjustment is required.



One-time maintenance cost

Travel expenses | 0 USD

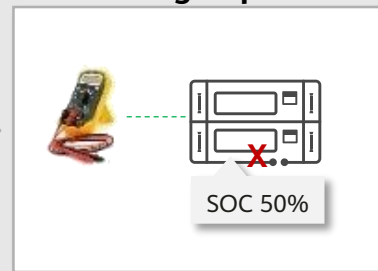
Maintenance labor cost | ~50 USD

### Traditional Solution - Experts are required for spare pack adjustment

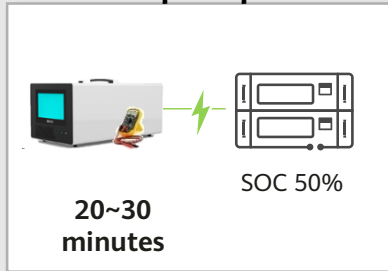
① Expert site visit



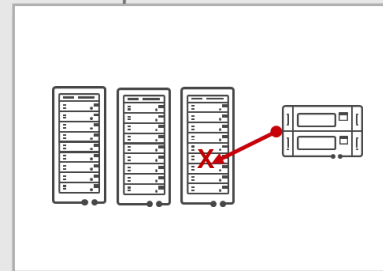
② Detect the SOC of damaged pack



③ Adjust the SOC of the spare pack.



④ Replace the spare pack onsite.



One-time maintenance cost

Travel expenses | ~500 USD

Maintenance labor cost | ~150 USD

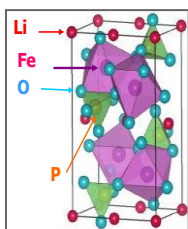
# LFP Cells + AI-aided Internal Short Circuit Analysis

## Predict Fire Hazard in Advance

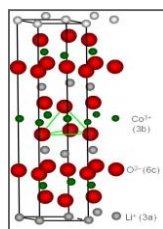
### LFP cells to improve safety

Stable architecture, hard to decompose

**LFP**  
Olive-shaped  
3D Structure  
Stable



**NCM**  
Multi-layer  
2D Structure  
Unstable



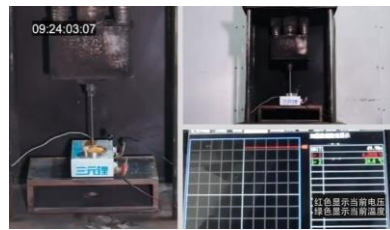
Less fire & explosion risk under over-charging

LFP: **Only smoke**  
during piercing test



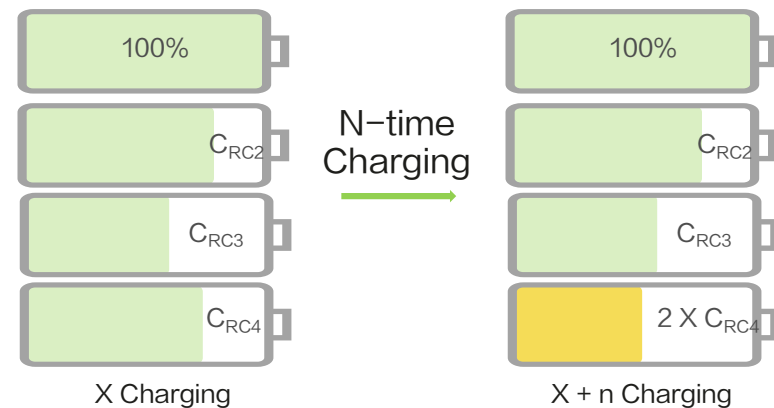
Surface Temp: 200-400°C

NCM: **Severe burning**  
during piercing test



Surface Temp: >500°C

### Internal short-circuit



$$\Delta C_{RC4} = 2 \times C_{RC4} - C_{RC4}$$



- **Accurately detect key parameters** (e.g., internal resistance)
- **AI aids** to analyze separator status
- **Alarm short-circuit** to prevent fire risk

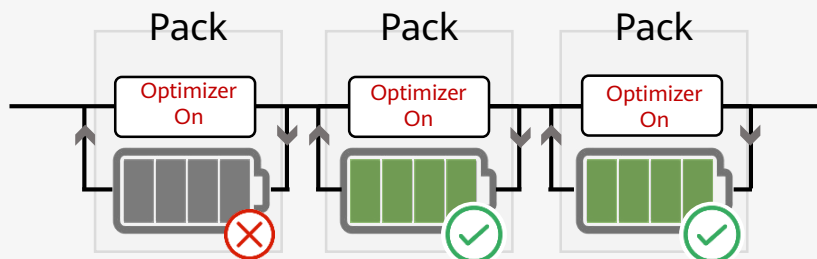
# Modular design, No Quick-wear Parts

System Availability  $\geq 99.9\%$

**Huawei Solution - System availability  $\geq 99.9\%$**

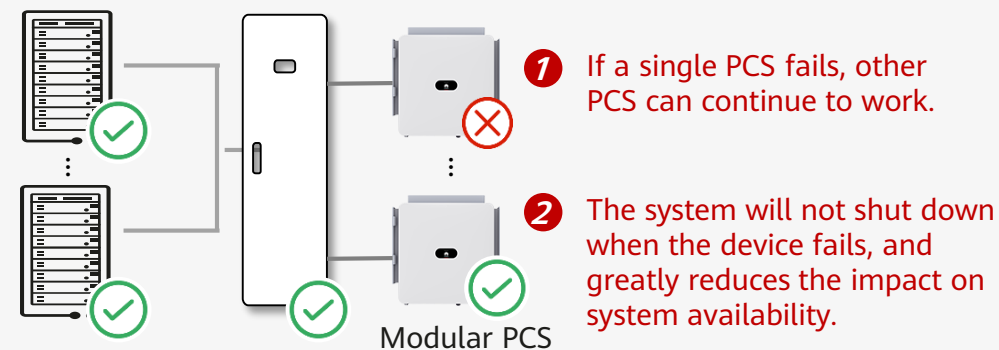
## Inside the Battery Rack

The faulty pack can be cut-out separately without affecting the charging and discharging of other pack.



## Outside the Container

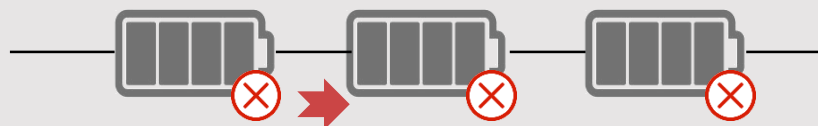
Modular PCS design minimizes the impact of PCS faults on the ESS.



**Traditional Solution - Fault impact reduces system availability**

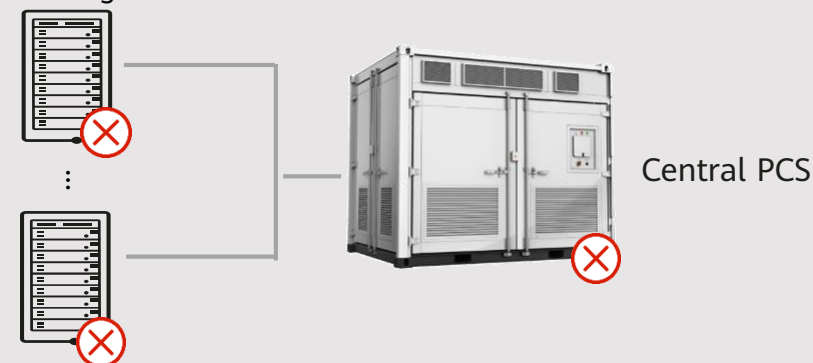
## Inside the Battery Rack

Battery rack will stop working with single pack failure.



## Outside the Container

All battery racks cannot be charged or discharged due to a single PCS failure.



# Thank you.

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每个组织，构建万物互联的智能世界。

Bring digital to every person, home and  
organization for a fully connected,  
intelligent world.

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